What is claimed is:

1. A machine-vision head for measuring a three-dimensional geometry of a device having a surface to be measured, comprising:

a projector, the projector comprising:

a first light source having a projection optical axis that intersects the device;

a projection-imaging element positioned along the projection optical axis and spaced from the first light source; and

a projection-pattern element positioned between the first light source and the projection imaging element along the projection optical axis, the projection-pattern element having a repeating sine-wave light-modulation pattern as measured along a line on the projection-pattern element; and

an imager, the imager having a reception optical axis that intersects the device substantially at the projection optical axis.

2. The machine-vision head according to claim 1, wherein the projection-pattern element light-modulation pattern includes a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

3. The machine-vision head according to claim 2, wherein the first light source includes a elongated incandescent filament having a dimension along a longitudinal axis substantially longer than a width, wherein the longitudinal axis of the filament is substantially perpendicular to the projection optical axis and substantially parallel to the grid lines of the projection-pattern element.

4. The machine-vision head according to claim 2, further comprising a projection mask having an elongated aperture having a dimension along a length axis substantially longer than a dimension along a width axis perpendicular to the length axis, and wherein the length axis is substantially parallel to the grid lines of the projection-pattern element.

5. The machine-vision head according to claim 4, wherein the projection mask limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

6. The machine-vision head according to claim 4, further comprising a projection-mask actuator operable to adjust a position of the projection mask.

7. The machine-vision head according to claim 1, further comprising a light-intensity controller, coupled to receive intensity information regarding light output from the first light source, that outputs a control signal based on a measured intensity of light from the first light source.

8. The machine-vision head according to claim 7, wherein the control signal is operatively coupled to the first light source to control light output based on the measured light intensity in a feedback manner.

9. The machine-vision head according to claim 7, wherein the control signal is operatively coupled to the imager to control an amount of light received in an imaging cycle of the imager.

10. The machine-vision head according to claim 1, further comprising a condensing imaging element positioned between the first light source and the projection-pattern element along the projection optical axis.

11. The machine-vision head according to claim 1, further comprising a focussing reflector that substantially focusses an image of the first light source adjacent to the first light source.

12. The machine-vision head according to claim 11, wherein the reception optical axis is oriented to be at substantially a right angle to a direction of scanning, and the projection optical axis is oriented to be at substantially a forty-five-degree angle to the direction of scanning.

13. The machine-vision head according to claim 12, wherein a major plane of the projection-imaging element is oriented substantially perpendicular to the projection optical axis and a major plane of the projection-pattern element is oriented substantially perpendicular to the projection optical axis.

14. The machine-vision head according to claim 1, further comprising a second light source that directs substantially unpatterned light onto the device, the second light source being activated to obtain two-dimensional intensity data about the device from the imager.

15. A machine-vision system for inspecting a device, comprising:

(1) an inspection station, the inspection station including:

(a) a projector, the projector comprising:

a first light source having a projection optical axis that intersects the device;

a projection-imaging element positioned along the projection optical axis and spaced from the first light source; and

a projection-pattern element positioned between the first light source and the projection imaging element along the projection optical axis, the projection-pattern element having a repeating sine-wave light-modulation pattern as measured along a line on the projection-pattern element; and

(b) an imager, the imager having a reception optical axis that intersects the device when the inspection station is in operation, the imager maintained in a substantially fixed relationship to the pattern projector, the imager including at least three lines of semiconductor imaging pixels;

(2) a scanner mechanism that moves the imager relative to the device such that different portions of the device are successively imaged by the imager, wherein the first light source is activated in conjunction with the imager to obtain three-dimensional device geometry data regarding the device; and

(3) a comparator coupled to the imager, the comparator comparing one or more characteristics of the acquired three-dimensional device geometry data with an intended predetermined geometry to produce a signal indicative of any device geometry departure of an actual device geometry from the intended predetermined geometry.

16. The system according to claim 15, wherein the projection-pattern element light-modulation pattern includes a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

17. The system according to claim 16, wherein the first light source includes a elongated incandescent filament having a dimension along a longitudinal axis substantially longer than a width, wherein the longitudinal axis of the filament is substantially perpendicular to the projection optical axis and substantially parallel to the grid lines of the projection-pattern element.

18. The system according to claim 15, further comprising a projection mask having an elongated aperture having a dimension along a length axis substantially longer than a dimension along a width axis perpendicular to the length axis, and wherein the length axis is substantially parallel to the grid lines of the projection-pattern element.

19. The system according to claim 18, wherein the projection mask limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

20. The system according to claim 15, further comprising a light-intensity controller, coupled to receive intensity information regarding light output from the light source, that outputs a control signal based on a measured intensity of light from the light source, wherein the control signal is operatively coupled to the imager to control an amount of light received in an imaging cycle of the imager.

21. The system according to claim 15, further comprising a focussing reflector that substantially focusses an image of the light source adjacent to the light source.

22. The system according to claim 15, further comprising a condensing imaging element positioned between the first light source and the projection-pattern element along the projection optical axis.

23. The system according to claim 15, wherein a major plane of the projection-imaging element is oriented substantially perpendicular to the projection optical axis and a major plane of the projection-pattern element is oriented substantially perpendicular to the projection optical axis.

24. The system according to claim 15, further comprising a second light source that directs substantially unpatterned light onto the device, the second light source being activated in conjunction with the imager to obtain two-dimensional intensity data about the device from the imager.

25. A method for measuring a three-dimensional geometry of a device having a surface to be measured, comprising:

projecting patterned light having a spatial-modulation pattern; the projecting pattern light comprising:

projecting substantially unpatterned light;

spatially modulating the unpatterened light with a sine-wave spatial modulation pattern to produce spatial-modulation patterned light; and

imaging the spatial-modulation patterned light onto the device;

scanning the device within the spatial-modulation patterned light; and

receiving reflected light from the device into at least three linear imager regions.

26. The method according to claim 25, wherein the spatially modulating includes modulating with a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

27. The method according to claim 26, wherein the projecting substantially unpatterned light source includes a elongated light beam, wherein a longitudinal axis of the beam is perpendicular to the direction of projection and parallel to the grid lines.

28. The method according to claim 26, further comprising projection masking to an elongated aperture having a length axis substantially greater that a width axis, and wherein the length axis is substantially parallel to the grid lines of the pattern.

29. The method according to claim 28, wherein the projection masking limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

30. The method according to claim 28, further comprising a adjusting a position of the projection masking.

31. The method according to claim 25, further comprising generating a light-intensity control signal based on intensity information regarding the projected light .

32. The method according to claim 31, further comprising controlling a light source to control light output based on the measured light intensity in a feedback manner.

33. The method according to claim 31, further comprising controlling an imager to control an amount of light received in an imaging cycle of the imager.

34. The method according to claim 25, further comprising condensing light onto the projection-pattern along the projection optical axis.

35. The method according to claim 25, further comprising reflectively focussing to substantially focus an image of the light source adjacent to the light source.

36. The method according to claim 25, wherein the reception optical axis is oriented to be at substantially a right angle to a direction of scanning, and the projection optical axis is oriented to be at substantially a forty-five-degree angle to the direction of scanning.

37. A machine-vision head for measuring a three-dimensional geometry of a device having a surface to be measured, comprising:

a projector, the projector comprising:

a first light source having a projection optical axis that intersects the device;

a condensing imaging element positioned along the projection optical axis and spaced from the light source by a distance D_4;

a projection imaging element positioned along the projection optical axis and spaced from the condensing imaging element by a distance D_3; and

a projection-pattern element l positioned along the projection optical axis and between the condensing imaging element and the projection imaging element and spaced from the projection imaging element by a distance D_2, the projection-pattern element having a repeating light-modulation pattern that modulates light from the first light source to generate a patterned light useful for determining three-dimensional geometry of the device, wherein a projection-imaging-element-to-device distance D_1 and the distance D_2 are configured to focus an image of projection-pattern element at the surface of device, and the distance D_3 and the distance D_4 are configured so as focus an image of the light source onto the projection-pattern imaging element; and

an imager, the imager having a reception optical axis that intersects the device substantially at the projection optical axis, the imager receiving the patterned light as reflected by the device.

38. The machine-vision head according to claim 37, wherein the projection-pattern element light-modulation pattern includes a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

39. The machine-vision head according to claim 37, wherein the first light source includes a elongated incandescent filament having a dimension along a longitudinal axis substantially longer than a width, wherein the longitudinal axis of the filament is substantially perpendicular to the projection optical axis and substantially parallel to a pattern feature of the projection-pattern element.

40. The machine-vision head according to claim 39, further comprising a projection mask having an elongated aperture having a dimension along a length axis substantially longer than a dimension along a width axis perpendicular to the length axis, and wherein the length axis is substantially parallel to the pattern feature of the projection-pattern element.

41. The machine-vision head according to claim 40, wherein the projection-pattern element light-modulation pattern includes a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines, the pattern feature being the grid lines, and wherein the projection mask limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

42. The machine-vision head according to claim 40, further comprising a projection-mask actuator operable to adjust a position of the projection mask.

43. The machine-vision head according to claim 37, further comprising a light-intensity controller, coupled to receive intensity information regarding light output from the first light source, that outputs a control signal based on a measured intensity of light from the first light source.

44. The machine-vision head according to claim 43, wherein the control signal is operatively coupled to the first light source to control light output based on the measured light intensity in a feedback manner.

45. The machine-vision head according to claim 43, wherein the control signal is operatively coupled to the imager to control an amount of light received in an imaging cycle of the imager.

46. The machine-vision head according to claim 37, further comprising a condensing imaging element positioned between the first light source and the projection-pattern element along the projection optical axis.

47. The machine-vision head according to claim 37, further comprising a focussing reflector that substantially focusses an image of the first light source adjacent to the first light source.

48. The machine-vision head according to claim 47, wherein the reception optical axis is oriented to be at substantially a right angle to a direction of scanning, and the projection

optical axis is oriented to be at substantially a forty-five-degree angle to the direction of scanning.

48. The machine-vision head according to claim 48, wherein a major plane of the projection-imaging element is oriented substantially perpendicular to the projection optical axis and a major plane of the projection-pattern element is oriented substantially perpendicular to the projection optical axis.

50. The machine-vision head according to claim 37, further comprising a second light source that directs substantially unpatterned light onto the device, the second light source being activated to obtain two-dimensional intensity data about the device from the imager.

51. A machine-vision system for inspecting a device, comprising:

(1) an inspection station, the inspection station including:

(a) a projector, the projector comprising:

a first light source having a projection optical axis that intersects the device;

a condensing imaging element positioned along the projection optical axis and spaced from the light source by a distance D_4;

a projection imaging element positioned along the projection optical axis and spaced from the condensing imaging element by a distance D_3; and

a projection-pattern element I positioned along the projection optical axis and between the condensing imaging element and the projection imaging element and spaced from the projection imaging element by a distance D_2, the projection-pattern element having a repeating light-modulation pattern that modulates light from the first light source to generate a patterned light useful for determining three-dimensional geometry of the device, wherein a projection-imaging-element-to-device distance D_1 and the distance D_2 are configured to focus an image of projection-pattern element at the surface of device, and the distance D_3 and the distance D_4 are configured so as focus an

image of the light source onto the projection-pattern imaging element; and

(b) an imager, the imager having a reception optical axis that intersects the device substantially at the projection optical axis, the imager receiving the patterned light as reflected by the device;

(2) a scanner mechanism that moves the imager relative to the device such that different portions of the device are successively imaged by the imager, wherein the first light source is activated in conjunction with the imager to obtain three-dimensional device geometry data regarding the device; and

(3) a comparator coupled to the imager, the comparator comparing one or more characteristics of the acquired three-dimensional device geometry data with an intended predetermined geometry to produce a signal indicative of any device geometry departure of an actual device geometry from the intended predetermined geometry.

52. The system according to claim 51, wherein the projection-pattern element light-modulation pattern includes a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

53. The system according to claim 52, wherein the first light source includes a elongated incandescent filament having a dimension along a longitudinal axis substantially longer than a width, wherein the longitudinal axis of the filament is substantially perpendicular to the projection optical axis and substantially parallel to the grid lines of the projection-pattern element.

54. The system according to claim 51, further comprising a projection mask having an elongated aperture having a dimension along a length axis substantially longer than a dimension along a width axis perpendicular to the length axis, and wherein the length axis is substantially parallel to the grid lines of the projection-pattern element.

55. The system according to claim 54, wherein the projection mask limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

56. The system according to claim 51, further comprising a light-intensity controller, coupled to receive intensity information regarding light output from the light source, that outputs a control signal based on a measured intensity of light from the light source, wherein the control signal is operatively coupled to the imager to control an amount of light received in an imaging cycle of the imager.

57. The system according to claim 51, further comprising a focussing reflector that substantially focusses an image of the light source adjacent to the light source.

58. The system according to claim 51, further comprising a condensing imaging element positioned between the first light source and the projection-pattern element along the projection optical axis.

59. The system according to claim 51, wherein a major plane of the projection-imaging element is oriented substantially perpendicular to the projection optical axis and a major plane of the projection-pattern element is oriented substantially perpendicular to the projection optical axis.

60. The system according to claim 51, further comprising a second light source that directs substantially unpatterned light onto the device, the second light source being activated in conjunction with the imager to obtain two-dimensional intensity data about the device from the imager.

61. A method for measuring a three-dimensional geometry of a device having a surface to be measured, comprising:

projecting patterned light having a spatial-modulation pattern; the projecting pattern light comprising:

projecting substantially unpatterned light;

spatially modulating the unpatterened light with a sine-wave spatial modulation pattern to produce spatial-modulation patterned light; and

imaging the spatial-modulation patterned light onto the device;

scanning the device within the spatial-modulation patterned light; and

receiving reflected light from the device into at least three linear imager regions.

62. The method according to claim 61, wherein the spatially modulating includes modulating with a repeating pattern of grid lines having substantially constant density along lines in a direction parallel to the grid lines and a sine-wave density along lines in a direction perpendicular to the grid lines.

63. The method according to claim 62, wherein the projecting substantially unpatterned light source includes a elongated light beam, wherein a longitudinal axis of the beam is perpendicular to the direction of projection and parallel to the grid lines.

64. The method according to claim 62, further comprising projection masking to an elongated aperture having a length axis substantially greater that a width axis, and wherein the length axis is substantially parallel to the grid lines of the pattern.

65. The method according to claim 64, wherein the projection masking limits the projected light to less than about three sine-wave cycles of the sine-wave pattern.

66. The method according to claim 65, further comprising a adjusting a position of the projection masking.

67. The method according to claim 66, further comprising generating a light-intensity control signal based on intensity information regarding the projected light .

68. The method according to claim 67, further comprising controlling a light source to control light output based on the measured light intensity in a feedback manner.

69. The method according to claim 68, further comprising controlling an imager to control an amount of light received in an imaging cycle of the imager.

70. The method according to claim 69, further comprising condensing light onto the projection-pattern along the projection optical axis.

71. The method according to claim 61, further comprising reflectively focussing to substantially focus an image of the light source adjacent to the light source.

72. The method according to claim 61, wherein the reception optical axis is oriented to be at substantially a right angle to a direction of scanning, and the projection optical axis is oriented to be at substantially a forty-five-degree angle to the direction of scanning.

73. A machine-vision system for inspecting a device, said machine-vision system comprising:

a light source for propagating light to the device;

an image detector that receives light from the device;

a light sensor assembly receiving a portion of the light from the light source, said light sensor assembly producing an output responsive to the intensity of the light received at the light sensor assembly; and

a controller for controlling the amount of light received by the image detector, said controller controlling the amount of light within a desired range in response to the output from the light sensor.

74. The system of claim 73 wherein the light sensor assembly further comprises:

a beam splitter positioned between the light source and the device; and

a light sensor positioned to receive light from the beam splitter.

75. The system of claim 74 wherein the beam splitter filters infrared light from the light source.

76. The system of claim 73 further comprising a power supply which supplies power to the light source, said controller controlling the amount of light received by the image detector by controlling the amount of power output from the power supply.

77. The system of claim 73 wherein said controller controls the amount of light received by the image detector by controlling the amount time the image detector receives light to acquire an image.

78. The system of claim 73 wherein the image detector further comprises an array of imaging pixels, wherein said controller controls the amount of light received by the image

detector by controlling the amount time the array of imaging pixels receives light to acquire an image.

79. The system of claim 78 further comprising a memory device which stores correction values for at least one of the pixels in said array of imaging pixels, wherein the value associated with said at least one of the pixels is corrected with a correction value stored in said memory.

80. The system of claim 73 wherein said light sensor assembly further comprises a photo diode.

81. A machine-vision system for inspecting a device, said machine-vision system comprising:

a light source for propagating light to the device;

an image detector that receives light from the device; and

a cooling element attached to said imaging device, said cooling element removing heat produced by the image detector to keep the image detector within a selected temperature range.

82. The system of claim 81, wherein the cooling element is a thermoelectric semiconductor unit.

83. The system of claim 81, wherein the image detector is an array of imaging pixels.

84. The system of claim 81, wherein the image detector is an array of semiconductor imaging pixels, said thermoelectric semiconductor unit further comprising:

a temperature sensor for sensing the temperature of the array of semiconductor imaging pixels;

a cool portion attached to the array of semiconductor imaging pixels to form a thermally conductive path between the array of semiconductor imaging pixels and the thermoelectric semiconductor unit;

a heat rejection portion; and

a controller for controlling the amount of power input to the thermoelectric semiconductor to keep the image detector within a selected temperature range.

85. A machine-vision system for inspecting a device, said machine-vision system comprising:

a strobed light source for propagating light to the device;

an image detector that receives light from the device, said image detector remaining in a fixed position with respect to the strobed light source; and

translation element that moves the strobed light source and image detector with respect to the device.

86. The machine-vision system for inspecting a device of claim 85 comprising a ring light source.

87. The machine-vision system for inspecting a device of claim 85 further comprising a strobed light controller which controls the strobed light source to produce light having a first level and to produce light having a second level, said first level different from the first level.

88. The machine-vision system for inspecting a device of claim 86 wherein the image detector further comprises:

an array of imaging pixels; and

an imaging pixel controller which controls the amount of light received by the image detector by controlling the amount time the array of imaging pixels receives light to acquire an image.

89. The system of claim 87 further comprising a memory device which stores correction values for at least one of the pixels in said array of imaging pixels, wherein the value associated with said at least one of the pixels is corrected with a correction value stored in said memory.

90. The system of claim 87 further comprising a memory device which stores a first correction value associated with the first level of light from the strobed light source, and

a second correction value associated with the second level of light from the strobed light source for at least one of the pixels in said array of imaging pixels, wherein the values associated with said at least one of the pixels is corrected with the first and second correction values stored in said memory.

91. The machine-vision system for inspecting a device of claim 86 wherein said strobed light controller controls the strobed light source to produce light having a first level and alternated with light having a second level.

92. The machine-vision system for inspecting a device of claim 86 comprising a strobed ring light source, said strobed light controller controlling the strobed light source and the strobed ring light source.

93. The machine-vision system for inspecting a device of claim 92 wherein the strobed light controller controls the strobed ring light source to strobe alternatively with the strobed light at the first level and at the second level.

94. The machine-vision system for inspecting a device of claim 86 wherein the image detector is comprised of a first line of pixels and a second line of pixels, said machine vision system further comprising a strobed ring light source, wherein said strobed light controller controls the strobed ring light source to produce light for the first line of pixels and the second line of pixels.

95. A method for acquiring physical information associated with of a device using a machine-vision station having a light source and having an image detector, said method comprising the steps of:

projecting light from the light source to the device;

receiving light reflected from the device into an image detector; and

controlling the amount of light received at the image detector to a value within a desired range.

96. The method of claim 95, wherein the step of controlling the amount of light received at the image detector further comprises the steps of:

sensing the projected from the light source; and

controlling the amount of power input to the light source in response to the value produced by said sensing step.

97. The method of claim 95, wherein the image detector further comprises an array of pixels which produce a signal dependent on the length of time the pixel is exposed to the reflected light, wherein the step of controlling the amount of light received at the image detector further comprises the steps of:

sensing the projected from the light source; and

controlling the length of time the image detector is exposed to reflected light in response to the value produced by said sensing step.

98. The method of claim 95 wherein the step of controlling the amount of light received at the image detector further comprises the steps of:

sensing the reflected from the device; and

controlling the amount of power input to the light source in response to the value produced by said sensing step.

99. The method of claim 24 wherein the image detector further comprises an array of pixels which produce a signal dependent on the length of time the pixel is exposed to the reflected light, wherein the step of controlling the amount of light received at the image detector further comprises the steps of:

sensing the reflected from the device; and

controlling the length of time the image detector is exposed to reflected light in response to the value produced by said sensing step.

100. A method for acquiring physical information associated with of a device using a machine-vision station having a light source and having an image detector, said method comprising the steps of:

projecting light from the light source to the device;

receiving light reflected from the device into an image detector; and

removing heat produced by the image detector to keep the image detector within a selected temperature range.

101. The method of claim 29, wherein the step of removing heat produced by the image detector further comprises attaching a thermoelectric semiconductor unit to the image detector.

102. A method for acquiring physical information associated with of a device using a machine-vision station having a light source and having an image detector, said method comprising the steps of:

fixing the relationship between the light source and the image detector;
moving the light source and the image detector with respect to the device;
projecting strobed light from the light source to the device; and
receiving light reflected from the device into an image detector.

103. The method of claim 102 wherein the wherein the step of projecting strobed light from the light source to the device further comprises the steps of:

producing a first level of strobed light from the light source; and
producing a second level of strobed light from the light source.

104. The method of claim 103 further comprising the step of producing a strobed light from a ring light.

105. The method of claim 104 wherein the wherein the step of projecting strobed light from the light source to the device further comprises the steps of:

producing a first level of strobed light from the light source;
producing a second level of strobed light from the light source; and
alternating the strobed light of the first level with the strobed light of the second level.

106. A manufacturing system, comprising:

a semiconductor part fabrication unit that fabricates a part for a semiconductor device; and

an inspection station, the inspection station further comprising:

(a) a light source projecting light onto the device;

(b) an image detector which receives light reflected from the device, the image detector including a plurality of lines of semiconductor imaging pixels;

© a light sensor assembly receiving a portion of the light from the light source, said light sensor assembly producing an output responsive to the intensity of the light received at the light sensor assembly; and

(d) a controller for controlling the amount of light received by the image detector, said controller controlling the amount of light within a desired range in response to the output from the light sensor.

107. The manufacturing system of claim 106 wherein the inspection station further comprises memory for storing correction values associated with at least one of the pixels in the image detector.

108. The manufacturing system of claim 106, wherein the inspection station further comprises a light source controller for producing strobed light of a first level and strobed light of a second level.

109. The manufacturing system of claim 108 wherein the inspection station further comprises a ring light.

110. The manufacturing system of claim 106 wherein the inspection station further comprises:

a ring light; and

a ring light controller for strobing the ring light, said ring light controller strobing the ring light for each of said plurality of lines of pixels in said image detector.

111. A machine-vision system for inspecting at least one device, the machine-vision system comprising:

a first inspection station, the first inspection station comprising:

a surface for inspecting at least one device, said surface having an opening therein;

an inspection device positioned on one side of the inspection surface; and

an elevator that places at least one device within the opening in the surface from another side of the inspection surface opposite the one side of the inspection surface, said elevator presenting at least one device to the surface for inspecting at least one device.

112. The system of claim 111, wherein the elevator further comprises a compartment for holding at least one device, said elevator placing at least one device within the opening in the surface and presenting the device to the surface for inspecting the device.

113. The system of claim 112, the first inspection station further comprising:

a light source that propagates light to the device when the device is positioned on the surface for inspecting the device; and

an image detector that receives light from the device.

114. The system of claim 112 wherein the elevator and the compartment for holding a at least one device is aligned with the opening.

115. The system of claim 111 wherein the elevator is aligned with the opening.

116. The system of claim 111 further comprising:

a first tray for holding at least one device;

a first tray for holding at least one device

a tray-transfer mechanism; and

a second inspection station, said tray-transfer mechanism operating to move at least one device from the first inspection station to a second inspection station.

117. The system of claim 116 wherein the tray-transfer mechanism further comprises an inverting mechanism inverts the first tray and the second tray so as to position the at least one device within the second tray so that another side of the at least one device can be inspected.

118. The system of claim 116 wherein one side of the at least one device is inspected at the first inspection position and wherein another side of the at least one device is inspected at the second inspection position.

119. The system of claim 117 further comprising;

a third inspection station; and

a fourth inspection station, said tray-transfer device moving the device between the first and third inspection stations, and between the second and fourth inspection stations.

120. The system of claim 119 wherein the inverting mechanism is positioned between the third inspection station and the second inspection station.

121. A machine-vision system for inspecting a plurality of devices positioned within a plurality of device-carrying trays, the machine-vision system comprising:

a first slide clamp adapted to hold a first tray and a second tray, said first slide clamp moving the first tray from a first inspection station to a second inspection station, and moving the second tray from the second inspection station to a flip station; and

a second slide clamp adapted to hold a third tray and a fourth tray, said second slide clamp moving the third tray from the flip station to a third inspection station, and moving the fourth tray from the third inspection station to a fourth station.

122. The machine-vision system of claim 121 wherein the first slide clamp has two openings therein, each opening sized to receive one of the first device-carrying tray, or the second device-carrying tray, said first slide clamp further comprising:

a registration surface for registering the a surface of one of the first device-carrying tray, or the second device-carrying tray; and

a clamp for clamping one of the first device-carrying tray, or the second device-carrying tray in a desired position, said clamp positioned to clamp one of the first device-carrying tray, or the second device-carrying tray with respect to the two openings in the first slide clamp.

123. The machine-vision system of claim 121 further comprising a machine-vision inspection head for scanning the devices within one of the first device-carrying tray, or the second device-carrying tray at the first inspection station, said inspection head further comprising:

a light source that propagates light to the device when positioned on the surface for inspecting the device; and

an image detector that receives light from the device.

124. The machine-vision system of claim 121 wherein the first tray and a second tray have a substantially rectangular footprint, and wherein the first slide clamp moves at least one of the first tray and the second tray in a direction substantially parallel to the short sides of the at least one of the first tray and the second tray.

125. The machine-vision system of claim 124 further comprising a picker for picking devices which fail inspection from a tray.

126. The machine-vision system of claim 125 further comprising a source of devices that have passed inspection, said picker substituting devices that have passed inspection for the devices that have failed inspection.

127. The machine-vision system of claim 125 further comprising a source of devices that have passed inspection and have not passed inspection, said picker substituting devices that have passed inspection from the source for the devices that have failed inspection to produce a fourth tray filled with devices all of which have not passed inspection.

128. The machine-vision system of claim 127 further comprising:

a first location for the devices that have failed inspection; and

a second location for devices that have not passed inspection.

129. A machine-vision system for inspecting a tray populated with a plurality of devices, the machine-vision system comprising:

a first inspection station having a first inspection surface;

a compartment positioned adjacent the first inspection station, said compartment holding a plurality of trays; and

an elevator for elevating at least one of said trays from the compartment to the first inspection surface.

130. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 19 wherein the first inspection surface has an opening therein, said opening accommodating one of said plurality of trays.

131. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 129 wherein the first inspection surface has an opening therein, said opening accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the long dimension side of the tray.

132. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 129 wherein the first inspection surface has an opening therein, said opening accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the short dimension side of the tray.

133. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 128 further comprising

a second inspection station having a second inspection surface;

an elevator for moving at least one of the trays from the between a first position at the second inspection surface and a second position away from the second inspection surface.

134. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 129 wherein the compartment further comprises:

a door which folds from a closed position to an open position:

a first guide rail positioned on the inner surface of the door; and

a second guide rail positioned on the inner surface of the door, said first guide rail and said second guide rail spaced to receive at least one tray so that the tray can be placed between the first and second guide rails and guided into the compartment.

135. A machine-vision system for inspecting a tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface;

means for determining if at least one of the plurality of devices in a tray at the inspection station does not pass an inspection test; and

a failed device station for holding trays which hold devices having devices which have passed inspection and devices which have not passed inspection at which trays are formed in which all of the plurality of devices do not pass inspection.

136. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 135 further comprising a first picker for moving at least one of the plurality of devices between the inspection station and the failed device station.

137. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 136 wherein the first picker for moving at least one of the plurality of devices between the inspection station and the failed device station accommodates differently spaced devices within trays.

138. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 136 further comprising a second picker for moving at least one of the plurality of devices between the inspection station and the failed device station.

139. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 138 wherein the first picker and the second picker for moving at least one of the plurality of devices between the inspection station and the failed device station accommodates differently spaced devices within trays.

140. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 135 further comprising a compartment near the failed device station for housing trays in which all of the plurality of devices do not pass inspection.

141. A machine-vision system for inspecting a rectangular tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface; and

means for holding the rectangular tray which engage the sides of the tray with the shorter dimension.

142. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 141 wherein means for holding the rectangular tray which engage the sides of the tray with the shorter dimension includes a set of pins which engage detents in the shorter side of the tray.

143. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 142 wherein the pins force the tray to a datum registration surface.

144. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 141 further including means for moving the rectangular tray in a direction substantially parallel to the shorter dimension of the rectangular tray.

145. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 144 further including means for inspecting the rectangular tray in a direction substantially parallel to the longer dimension of the rectangular tray.

146. A machine-vision system for inspecting a rectangular tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface;

a 3D inspection device; and

a 2D inspection device.

147. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 146 wherein the 3D device and 2D device inspect the inspection surface synchronously.

148. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 147 wherein the inspection surface holds a first tray and a second tray.

149. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 146 wherein the 3D device and 2D device inspect the inspection surface asynchronously.

150. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 149 wherein the inspection surface holds a first tray and a second tray.

151. A method for acquiring physical information associated with a plurality of devices placed in a tray, the method comprising the steps of:

loading at least one tray into a compartment adjacent a first inspection station; and elevating the tray to the first inspection surface.

152. The method of claim 151 further comprising the steps of:

inspecting a first side of at least one of a plurality of devices within a first tray;

moving the first tray to a flip station; and

inspecting a second side of at least one of a plurality of devices within the second tray.

153. The method of claim 152, further including the step of removing at least one of a plurality of devices from the second tray if the at least one of a plurality of devices fails inspection.

154. The method of claim 152 further comprising the step of replacing at least one of a plurality of devices in the second tray that failed inspection with a device that passed inspection.

155. A machine-vision system for inspecting a device, the machine-vision system comprising:

an initial inspection station, the initial inspection station comprising:

a surface for inspecting the device, said surface having an opening therein; and

an elevator that places the device within the opening in the surface and presents the device to the surface for inspecting the device.

156. The system of claim 155 wherein the elevator further comprises a compartment for holding a plurality of devices, said elevator placing at least one of the plurality of devices within the opening in the surface and presenting the device to the surface for inspecting the device.

157. The system of claim 156, the initial inspection station further comprising:

a light source that propagates light to the device when the device is positioned on the surface for inspecting the device; and

an image detector that receives light from the device.

158. The system of claim 156 wherein the elevator and the compartment for holding a plurality of devices are aligned with the opening.

159. The system of claim 155 wherein the elevator is aligned with the opening.

160. The system of claim 155 further comprising a tray-transfer device that operates to move the device from the initial inspection station to a second inspection station.

161. The system of claim 160 further comprising an inverting mechanism that operates to invert the device so that the another side of the device can be inspected.

162. The system of claim 161 wherein one side of the device is inspected in the first inspection position and wherein another side of the device is inspected in the second inspection position.

161. The system of claim 160 further comprising a third inspection station and a fourth inspection station, said tray-transfer device moving the device between the first and third inspection stations, and between the second and fourth inspection stations.

162. The system of claim 9 wherein the inverting mechanism is positioned between the third inspection position and the second inspection position.

163. A machine-vision system for inspecting a plurality of devices positioned within a plurality of device-carrying trays, the machine-vision system comprising:

a first slide clamp for holding at least two trays, said slide clamp moving a first tray from a first inspection station to a second inspection station, and moving a second tray from the second inspection station to a flip station; and

a second slide clamp for holding at least two trays, said slide clamp moving a third tray from the flip station to a third inspection station, and moving a fourth tray from the third inspection station to a fourth station.

164. The machine-vision system of claim 163 wherein the first slide clamp has two openings therein, each opening sized to receive a device-carrying tray, said first slide clamp further comprising:

a registration surface for registering the a surface of the device-carrying tray; and

a clamp for clamping the tray in a desired position, said clamp positioned to clamp the tray with respect to the opening in the slide clamp.

165. The machine-vision system of claim 163 further comprising a machine-vision inspection head for scanning the devices within the trays at the first inspection station, said inspection head further comprising:

a light source that propagates light to the device when positioned on the surface for inspecting the device; and

an image detector that receives light from the device.

166. The machine-vision system of claim 163 wherein the flip station further comprises a mechanism for flipping the devices carried in a tray, the mechanism further comprising:

a first jaw having a surface for receiving a tray;

a second jaw having a surface for receiving a tray;

a mover for moving the first jaw, a first tray having a plurality of devices, a second tray, and the second jaw into engagement with each other, said first tray associated with the first jaw and the second tray associated with the second jaw; and

a rotator for rotating the first and second jaw.

167. The machine-vision system of claim 166 wherein the mover moves the first jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

168. The machine-vision system of claim 166 wherein the mover moves the first jaw and the second jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

169. The machine-vision system of claim 166 further comprising;

a picker for picking devices which fail inspection from a tray.

170. The machine-vision systemof claim 168 further comprising a source of devices that have passed inspection, said picker substituting devices that have passed inspection for the devices that have failed inspection.

171. A machine-vision system for inspecting a plurality of devices and for transferring the plurality of devices from being positioned in a first tray to being positioned in a second tray, the machine-vision system comprising:

a first jaw having a surface for receiving the first tray;

a second jaw having a surface for receiving the second tray;

a mover for moving the first jaw, the first tray having a plurality of devices, the second tray, and the second jaw into engagement with each other, said first tray associated with the first jaw and the second tray associated with the second jaw; and

a rotator for rotating the first and second jaw.

172. The machine-vision system of claim 171 further comprising;

a first conveyer for moving the first tray having a plurality of devices therein to the surface of the first jaw; and

a second conveyer for moving the second tray having a plurality of devices therein from surface of the second jaw.

173. The machine-vision system of claim 172 wherein one of the first or second jaws is capable of holding, in any position, a tray devoid of devices.

174. A machine-vision system for inspecting a tray populated with a plurality of devices, the machine-vision system comprising:

a first inspection station having a first inspection surface;

a compartment positioned adjacent the first inspection station, said compartment holding a plurality of trays; and

an elevator for elevating at least one of said trays from the compartment to the first inspection surface.

175. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 174 wherein the first inspection surface has an opening therein, said opening accommodating one of said plurality of trays.

176. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 174 wherein the first inspection surface has an opening therein, said opening accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the long dimension side of the tray.

177. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 174 wherein the first inspection surface has an opening therein, said opening accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the short dimension side of the tray.

178. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 174 further comprising

a second inspection station having a second inspection surface;

an elevator for moving at least one of the trays from the between a first position at the second inspection surface and a second position away from the second inspection surface.

179. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 22 wherein the compartment further comprises:

a door which folds from a closed position to an open position:

a first guide rail positioned on the inner surface of the door;

a second guide rail positioned on the inner surface of the door, said first guide rail and said second guide rail spaced to receive at least one tray so that the tray can be placed between the first and second guide rails and guided into the compartment.

180. A method for acquiring physical information associated with a plurality of devices placed in a tray, the method comprising the steps of:

loading at least one tray into a compartment adjacent a first inspection station; and

elevating the tray to the first inspection surface.

181. The method of claim 180 further comprising the steps of:

inspecting a first side of a device within a first tray;

moving the tray to a flip station;

flipping the devices and placing the flipped devices within a second tray; and

inspecting a second side of the device within the second tray.

182. The method of claim 181, further including the step of removing a device from the second tray if it fails inspection.

183. The method of claim 181, further comprising the step of replacing a device in the second tray that failed inspection with a device that passed inspection.

184. A machine-vision system for inspecting a plurality of devices and for inverting the plurality of devices from being positioned in a first tray, the machine-vision system comprising:

a first jaw having a surface for receiving the first tray;

a second jaw having a surface;

a mover for moving the first jaw, the first tray having a plurality of devices, and the second jaw into engagement with each other, said first tray associated with the first jaw; and

a rotator for rotating the first and second jaw.

185. The machine-vision system of claim 184 further comprising;

a first conveyer for moving the first tray having a plurality of devices therein to the first jaw; and

a second conveyer for moving the first tray having a plurality of devices therein from the first jaw.

186. The machine-vision system of claim 184 wherein the first jaw is capable of holding, in any position, a tray devoid of devices.

187. The machine-vision system of claim 184 further comprising;
a slider for transferring the inverted devices from the second jaw into the first tray.

188. A machine-vision system for inspecting at least one device, the machine-vision system comprising:
a first inspection station, the first inspection station comprising:
a surface for inspecting at least one device, said surface having an opening therein;
an inspection device positioned on one side of the inspection surface; and
an elevator that places at least one device within the opening in the surface from another side of the inspection surface opposite the one side of the inspection surface, said elevator presenting at least one device to the surface for inspecting at least one device.

189. The system of claim 188 wherein the elevator further comprises a compartment for holding at least one device, said elevator placing at least one device within the opening in the surface and presenting the device to the surface for inspecting the device.

190. The system of claim 189, the first inspection station further comprising:
a light source that propagates light to the device when the device is positioned on the surface for inspecting the device; and
an image detector that receives light from the device.

191. The system of claim 189 wherein the elevator and the compartment for holding a at least one device is aligned with the opening.

192. The system of claim 188 wherein the elevator is aligned with the opening.

193. The system of claim 188 further comprising:

a first tray for holding at least one device;

a first tray for holding at least one device

a tray-transfer mechanism; and

a second inspection station, said tray-transfer mechanism operating to move at least one device from the first inspection station to a second inspection station.

194. The system of claim 193 wherein the tray-transfer mechanism further comprises an inverting mechanism inverts the first tray and the second tray so as to position the at least one device within the second tray so that another side of the at least one device can be inspected.

195. The system of claim 193 wherein one side of the at least one device is inspected at the first inspection position and wherein another side of the at least one device is inspected at the second inspection position.

196. The system of claim 194 further comprising;

a third inspection station; and

a fourth inspection station, said tray-transfer device moving the device between the first and third inspection stations, and between the second and fourth inspection stations.

197. The system of claim 195 wherein the inverting mechanism is positioned between the third inspection station and the second inspection station.

198. A machine-vision system for inspecting a plurality of devices positioned within a plurality of device-carrying trays, the machine-vision system comprising:

a first slide clamp adapted to hold a first tray and a second tray, said first slide clamp moving the first tray from a first inspection station to a second inspection station, and moving the second tray from the second inspection station to a flip station; and

a second slide clamp adapted to hold a third tray and a fourth tray, said second slide clamp moving the third tray from the flip station to a third inspection station, and moving the fourth tray from the third inspection station to a fourth station.

199. The machine-vision system of claim 198 wherein the first slide clamp has two openings therein, each opening sized to receive one of the first device-carrying tray, or the second device-carrying tray, said first slide clamp further comprising:

a registration surface for registering the a surface of one of the first device-carrying tray, or the second device-carrying tray; and

a clamp for clamping one of the first device-carrying tray, or the second device-carrying tray in a desired position, said clamp positioned to clamp one of the first device-carrying tray, or the second device-carrying tray with respect to the two openings in the first slide clamp.

200. The machine-vision system of claim 198 further comprising a machine-vision inspection head for scanning the devices within one of the first device-carrying tray, or the second device-carrying tray at the first inspection station, said inspection head further comprising:

a light source that propagates light to the device when positioned on the surface for inspecting the device; and

an image detector that receives light from the device.

201. The machine-vision system of claim 198 wherein the first tray and a second tray have a substantially rectangular footprint, and wherein the first slide clamp moves at least one of the first tray and the second tray in a direction substantially parallel to the short sides of the at least one of the first tray and the second tray.

202. The machine-vision system of claim 201 further comprising a picker for picking devices which fail inspection from a tray.

203. The machine-vision system of claim 202 further comprising a source of devices that have passed inspection, said picker substituting devices that have passed inspection for the devices that have failed inspection.

204. The machine-vision system of claim 202 further comprising a source of devices that have passed inspection and have not passed inspection, said picker substituting devices that have passed inspection from the source for the devices that have failed inspection to produce a fourth tray filled with devices all of which have not passed inspection.

205. The machine-vision system of claim 204 further comprising:

a first location for the devices that have failed inspection; and

a second location for devices that have not passed inspection.

206. A machine-vision system for inspecting a tray populated with a plurality of devices, the machine-vision system comprising:

a first inspection station having a first inspection surface;

a compartment positioned adjacent the first inspection station, said compartment holding a plurality of trays; and

an elevator for elevating at least one of said trays from the compartment to the first inspection surface.

207. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 206 wherein the first inspection surface has an opening therein, said opening accommodating one of said plurality of trays.

208. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 206 wherein the first inspection surface has an opening therein, said opening accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the long dimension side of the tray.

209. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 206 wherein the first inspection surface has an opening therein, said opening

accommodating one of the plurality of trays, the trays having a rectangular shape, the machine-vision system further comprising finger elements positioned near the opening, said finger elements engaging the short dimension side of the tray.

210. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 208further comprising

a second inspection station having a second inspection surface;

an elevator for moving at least one of the trays from the between a first position at the second inspection surface and a second position away from the second inspection surface.

211. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 19 wherein the compartment further comprises:

a door which folds from a closed position to an open position:

a first guide rail positioned on the inner surface of the door; and

a second guide rail positioned on the inner surface of the door, said first guide rail and said second guide rail spaced to receive at least one tray so that the tray can be placed between the first and second guide rails and guided into the compartment.

212. A machine-vision system for inspecting a tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface;

means for determining if at least one of the plurality of devices in a tray at the inspection station does not pass an inspection test; and

a failed device station for holding trays which hold devices having devices which have passed inspection and devices which have not passed inspection at which trays are formed in which all of the plurality of devices do not pass inspection.

213. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 212 further comprising a first picker for moving at least one of the plurality of devices between the inspection station and the failed device station.

214. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 213 wherein the first picker for moving at least one of the plurality of devices

between the inspection station and the failed device station accommodates differently spaced devices within trays.

215. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 212 further comprising a second picker for moving at least one of the plurality of devices between the inspection station and the failed device station.

216. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 215 wherein the first picker and the second picker for moving at least one of the plurality of devices between the inspection station and the failed device station accommodates differently spaced devices within trays.

217. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 215 further comprising a compartment near the failed device station for housing trays in which all of the plurality of devices do not pass inspection.

218. A machine-vision system for inspecting a rectangular tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface; and

means for holding the rectangular tray which engage the sides of the tray with the shorter dimension.

219. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 218 wherein means for holding the rectangular tray which engage the sides of the tray with the shorter dimension includes a set of pins which engage detents in the shorter side of the tray.

220. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 219 wherein the pins force the tray to a datum registration surface.

221. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 218 further including means for moving the rectangular tray in a direction substantially parallel to the shorter dimension of the rectangular tray.

222. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 34 further including means for inspecting the rectangular tray in a direction substantially parallel to the longer dimension of the rectangular tray.

223. A machine-vision system for inspecting a rectangular tray populated with a plurality of devices, the machine-vision system comprising:

an inspection station including an inspection surface;

a 3D inspection device; and

a 2D inspection device.

224. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 223 wherein the 3D device and 2D device inspect the inspection surface synchronously.

225. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 224 wherein the inspection surface holds a first tray and a second tray.

226. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 225 wherein the 3D device and 2D device inspect the inspection surface asynchronously.

227. The machine-vision system for inspecting a tray populated with a plurality of devices of claim 226 wherein the inspection surface holds a first tray and a second tray.

228. A method for acquiring physical information associated with a plurality of devices placed in a tray, the method comprising the steps of:

loading at least one tray into a compartment adjacent a first inspection station; and

elevating the tray to the first inspection surface.

229. The method of claim 228 further comprising the steps of:

inspecting a first side of at least one of a plurality of devices within a first tray;

moving the first tray to a flip station; and

inspecting a second side of at least one of a plurality of devices within the second tray.

230. The method of claim 229, further including the step of removing at least one of a plurality of devices from the second tray if the at least one of a plurality of devices fails inspection.

231. The method of claim 229, further comprising the step of replacing at least one of a plurality of devices in the second tray that failed inspection with a device that passed inspection.

232. A machine-vision system for inspecting a device, said machine-vision system comprising:

a light source that propagates light to the device;

means for generating a moire pattern;

an image detector that receives light from the device;

a light-sensor assembly that receives a portion of the light from the light source and that produces an output responsive to the intensity of the light received at the light-sensor assembly; and

a computer and comparison system for manipulating a plurality of outputs from the light-sensor.

233. The system of claim 232 wherein the computer and comparison system for manipulating a plurality of outputs from the light-sensor is of sufficient granularity to allow the data obtained to be manipulated to detect various features.

234. The system of claim 233 wherein the data can be used to determine coplanarity of features on a device.

235. The system of claim 233 wherein the data can be used to determine warpage of a subtrate on a device.

236. The system of claim 233 wherein the data can be used to locate random features on a device.

237. The system of claim 233 wherein the data can be used to locate features on a device that is randomly situated.

238. The system of claim 233 further comprising:

means for moving the light source with respect to the device;

means for detecting the velocity of a the light source with respect to the device.

239. The system of claim 238 further comprising a linear postion encoder for specifying the times at which line scans are taken.

240. The system of claim 239 wherein the computer and comparison system measures the distance over which a portion of the device moves over one or more line scans and determines the velocity of the device.

241. The system of claim 233 wherein means for generating the moire pattern include a projection pattern element having a sine-wave element at the light source.

242. The system of claim 233 wherein means for generating the moire pattern include:

a first striped pattern;

a second striped pattern, said first striped pattern parallel to and offset from the plane of the second striped pattern, said first striped pattern and the second striped pattern positioned between the light source and the device.

243. A method for acquiring physical information associated with of a device using a machine-vision station having a light source and having an image detector, said method comprising:

projecting light from the light source to the device;

producing a moire pattern at the device;

gathering data with sufficient granularity such that a device can be randomly placed on an inspection surface for gathering data; and

manipulating the gathered data with a computer and comparator to identify various features of the device.

244. A method for acquiring physical information associated with of a device using a machine-vision station having a light source and having an image detector, said method comprising:

projecting light from the light source to the device;

producing a moire pattern at the device;

gathering data with sufficient granularity such that data can be gathered on randomly placed features on the device positioned on an inspection surface; and

manipulating the gathered data with a computer and comparator to identify various features of the device.

245. The method of claim 244 wherein manipulating the data can be used to determine coplanarity of a plurality of points on the device.

246. The method of claim 244 wherein manipulating the data can be used to determine position of a fiducial mark on a device at two separate times, said method further comprising calculating the velocity of the device with respect to the light source using the measured position and time.

247. The method of claim 244 wherein manipulating the data can be used to determine position of a feature on a device at a first scan time and at a second scan time, said method further comprising:

encoding the position of the feature at the first scan time;

encoding the position of the feature at the second scan time; and

calculating the velocity of the device with respect to the light source using the measured position and time.

248. A machine-vision head for inspecting a device, comprising:

(a) a pattern projector to provide projected illumination, the pattern projector including:

a light source, the light source providing light propagating generally along a projection optical axis, the projection optical axis intersecting the device when the machine-vision head is in operation;

a projection pattern element that spatially modulates the light and located so that the projection optical axis intersects the projection pattern element; and

a pattern projector imaging element located so that the projection optical axis intersects the pattern projector imaging element; and

(b) an imager, the imager having a reception optical axis, the reception optical axis intersecting the device when the machine-vision head is in operation, the imager maintained in a substantially fixed relationship to the pattern projector, the imager including at least three lines of semiconductor imaging pixels;

wherein a major plane of the projection pattern element, a major plane of the pattern projector imaging element, and a third plane are tilted one to another to substantially satisfy Schiempflug's condition that these three planes intersect at substantially one line.

249. The machine-vision head of claim 248, wherein the third plane contains the reception optical axis or lies substantially parallel to the reception optical axis.

250. The machine-vision head of claim 248, wherein the projection pattern element is maintained in a substantially fixed relationship to both the pattern projector and the imager when the machine-vision head is in operation.

251. The machine-vision head of claim 2481, wherein the pattern projection element includes a pattern whose intensity along a line segment varies as a sine wave.

252. A machine-vision system for inspecting a device, comprising:

(1) an inspection station, the inspection station including:

(a) a pattern projector, the pattern projector including:

a light source, the light source providing light propagating generally along a projection optical axis, the projection optical axis intersecting the device when the inspection station is in operation;

a projection pattern element that spatially modulates the light and located so that the projection optical axis intersects the projection pattern element; and

a pattern projector imaging element located so that the projection optical axis intersects the pattern projector imaging element; and

(b) an imager, the imager having a reception optical axis, the reception optical axis intersecting the device when the inspection station is in operation, the imager maintained in a substantially fixed relationship to the pattern

projector, the imager including at least three lines of semiconductor imaging pixels;

wherein a major plane of the projection pattern element, a major plane of the pattern projector imaging element, and a third plane are tilted one to another to substantially satisfy Schiempflug's condition that these three planes intersect at substantially one line, and wherein the imager provides acquired three-dimensional device geometry data regarding the device;

(2) a comparator coupled to the imager, the comparator comparing one or more characteristics of the acquired three-dimensional device geometry data with an intended predetermined geometry to produce a signal indicative of any device geometry departure of an actual device geometry from the intended predetermined geometry.

253. The system of claim 252, wherein the third plane contains the reception optical axis or lies substantially parallel to the reception optical axis.

254. The system of claim 252, wherein the projection pattern element is maintained in a substantially fixed relationship to both the pattern projector and the imager when the inspection station is in operation.

255. The system of claim 252, wherein the pattern projection element includes a pattern whose intensity along a line segment varies as a sine wave.

256. A method for high-speed scanning phase measurement of a device at a machine-vision station to acquire physical information associated with the device, the method comprising the steps of:

projecting light generally along a projection optical axis, the projection optical axis intersecting the device;

spatially modulating the light with a projection pattern located so that the projection optical axis intersects the projection pattern; and

imaging the spatially modulated light onto the device; and

receiving light reflected from the device along a reception optical axis with an imager maintained in a substantially fixed relationship to the projected spatially modulated light, the

imager including at least three lines of semiconductor imaging pixels, the reception optical axis intersecting the device;

generating data representing acquired three-dimensional device geometry data regarding the device from signals from the imager;

wherein the step of spatially modulating and the step of imaging the spatially modulated light provide a light pattern that is focused along a region of a third plane, wherein one of the at least three lines of semiconductor imaging pixels lies substantially within the third plane, and wherein a plane associated with the step of spatially modulating and a plane associated with the step of imaging the spatially modulated light, and a third plane are tilted one to another to substantially satisfy Schiempflug's condition that these three planes intersect at substantially one line, and wherein the reception optical axis lies within the third plane or is substantially parallel to the third plane.

257. The method of claim 256, wherein the step of spatially modulating includes modulating with a pattern whose intensity along a line segment varies as a sine wave.

258. The method of claim 256, further comprising the steps of:

comparing the acquired three-dimensional device geometry data with an intended predetermined geometry to produce a signal indicative of any device geometry departure of an actual device geometry from the intended predetermined geometry; and

controlling a manufacturing operation of the device to compensate for said device-geometry departure.

259. A machine-vision head for inspecting a device, comprising:

(a) a pattern projector, the pattern projector including:

a light source, the light source providing light propagating generally along a projection optical axis, the projection optical axis intersecting the device when the machine-vision head is in operation;

a projection pattern element that spatially modulates the light and located so that the projection optical axis intersects the projection pattern element; and

a pattern projector imaging element located so that the projection optical axis intersects the pattern projector imaging element; and

(b) an imager, the imager having a reception optical axis, the reception optical axis intersecting the device when the machine-vision head is in operation, the imager including:

at least three lines of semiconductor imaging pixels; and

a telecentric imaging element that focusses an image of the device onto the at least three lines of semiconductor imaging pixels.

260. A method for high speed, scanning phase measurement of a device at a machine-vision station to acquire physical information associated with the device, the method comprising the steps of:

projecting light generally along a projection optical axis, the projection optical axis intersecting the device when the machine-vision head is in operation;

spatially modulating the light with a projection pattern located so that the projection optical axis intersects the projection pattern;

imaging the spatially modulated light onto the device;

receiving light reflected from the device into an imager, the imager having a reception optical axis, the reception optical axis intersecting the device, the imager maintained in a substantially fixed relationship to the pattern projector, the imager including three lines of semiconductor imaging pixels, wherein the step of receiving includes telecentrically focussing an image of the device onto the at least three lines of semiconductor imaging pixels; and

generating data representing acquired three-dimensional device geometry data regarding the device.

261. The method of claim 260, further comprising the steps of:

comparing the acquired three-dimensional device geometry data with an intended predetermined geometry to produce a signal indicative of any device geometry departure of an actual device geometry from the intended predetermined geometry; and

controlling a manufacturing operation of the device to compensate for said device geometry departure, and

wherein the step of spatially modulating includes modulating with a projection pattern whose intensity along a line segment varies as a sine wave.

262. The method of claim 260, further comprising the step of:

blocking an infra-red component of the light.

263. A machine-vision head for inspecting a device, comprising:

(a) a pattern projector, the pattern projector including:

a light source, the light source providing light propagating generally along a projection optical axis, the projection optical axis intersecting the device when the machine-vision head is in operation;

a projection pattern element that spatially modulates the light and located so that the projection optical axis intersects the projection pattern element; and

a telecentric pattern projector imaging element that focusses an image of projection pattern element onto the device when the machine-vision head is in operation, and located so that the projection optical axis intersects the pattern projector imaging element; and

(b) an imager, the imager having a reception optical axis, the reception optical axis intersecting the device when the machine-vision head is in operation.

264. The machine-vision head of claim 263, wherein the imager further includes at least three lines of semiconductor imaging pixels, and wherein a major plane of the projection pattern element, a major plane of the pattern projector imaging element, and a third plane are tilted one to another to substantially satisfy Schiempflug's condition that these three planes intersect at substantially one line.

265. A machine-vision system for inspecting a device, the device having a first side and a second side, the machine-vision system comprising:

a first inspection station for inspecting a first side of a device;

a second inspection station for inspecting a second side of a device; and

a tray-transfer device that operates to move the device from the first inspection station to the second inspection station, said tray-transfer device further including an inverting mechanism that operates to invert the device so that the first second side of the device can be inspected at the first inspection station and the second side of the device can be inspected at the second inspection station.

266. The system of claim 265 wherein the inverting mechanism is positioned between the first inspection position and the second inspection position.

267. The machine-vision system of claim 265 wherein the inverting mechanism further comprises a mechanism for flipping the devices carried in a tray, the mechanism further comprising:

a first jaw having a surface for receiving a first tray;

a second jaw having a surface for receiving a second tray;

a mover for moving the first jaw, the first tray having a plurality of devices, the second tray, and the second jaw into engagement with each other, said first tray associated with the first jaw and the second tray associated with the second jaw; and

a rotator for rotating the first and second jaw.

268. The machine-vision system of claim 267 wherein the mover moves the first jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

269. The machine-vision system of claim 267 wherein the mover moves the first jaw and the second jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

270. The machine-vision system of claim 267 wherein the inverting mechanism moves the plurality of devices to the second tray such that the second sides of a plurality of devices are presented for inspection.

271. The machine-vision system of claim 267 wherein the rotator of the inverting mechanism moves the plurality of devices to the second tray such that the second sides of a plurality of devices are presented for inspection.

272. The machine-vision system of claim 271 wherein the mover of the inverting mechanism is adapted to place the plurality of devices in the second tray at the second inspection station.

273. The machine-vision system of claim 272 wherein the tray transfer device includes means for moving the second inspection station with respect to the inverting mechanisim.

274. The machine-vision system of claim 273 further comprising a picker for picking devices which fail inspection from the second tray.

275. A machine-vision system for inspecting a plurality of devices positioned within a plurality of device-carrying trays, the machine-vision system comprising:

a first tray adapted to carry a plurality of devices;

a second tray adapted to carry a plurality of devices;

a flip station for flipping the plurality of devices carried in a first tray from a first inspection position in the first tray to a second inspection position in the second tray.

276. The machine-vision system of claim 275 wherein the flip station further comprises:

a first jaw having a surface for receiving a first tray;

a second jaw having a surface for receiving a tray;

a mover for moving the first jaw, a first tray having a plurality of devices, a second tray, and the second jaw into engagement with each other, said first tray associated with the first jaw and the second tray associated with the second jaw; and

a rotator for rotating the first and second jaw.

277. The machine-vision system of claim 276 further comprising:

a first slide clamp for holding at least the first tray, said first slide clamp moving the first tray from a first inspection station to a flip station; and

a second slide clamp for holding at least the second tray, said second slide clamp moving the second tray from the flip station to the second inspection station.

278. The machine-vision system of claim 275 wherein the flip station further comprises a mechanism for flipping the devices carried in a tray, the mechanism further comprising means for limiting the motion of the rotator.

279. The machine-vision system of claim 276 wherein the mover moves the first jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

280. The machine-vision system of claim 276 wherein the mover moves the first jaw and the second jaw in a direction substantially perpendicular to the surface for receiving a tray associated with the first jaw.

281. A flipping mechanism for transferring a plurality of devices from a position in a first tray to a position in a second tray, the flipping mechanism comprising:

a first jaw having a surface adapted to receive the first tray;

a second jaw having a surface adapted to receive the second tray;

a mover for moving the first jaw, the first tray, the second tray, and the second jaw into engagement with each other, said first tray associated with the first jaw and the second tray associated with the second jaw; and

a rotator for rotating the first and second jaw.

282. The machine-vision system of claim 281 wherein the mover can be controlled to remove the first tray from a first inspection surface.

283. The machine-vision system of claim 281 wherein the mover can be controlled to place the second tray at a second inspection surface.

284. A method for acquiring physical information associated with a plurality of devices placed in a tray, the method comprising the steps of:

inspecting a first side of a device within a first tray;

removing the first tray from a first surface and placing the first tray at a flip station;

moving a second tray to a position near the first tray;

flipping the first tray and second tray to move the device from the first tray to the second tray and place the device in the second tray so that a second side of the device is presented in the second tray; and

inspecting a second side of the device within the second tray.

285. The method of claim 284, further including the step of moving the second tray to a second inspection surface.

286. A machine-vision system for inspecting a plurality of devices and for inverting the plurality of devices from being positioned in a first tray, the machine-vision system comprising:

a first jaw having a surface for receiving the first tray;

a second jaw having a surface;

a mover for moving the first jaw, the first tray having a plurality of devices, and the second jaw into engagement with each other, said first tray associated with the first jaw; and

a rotator for rotating the first and second jaw.

287. The machine-vision system of claim 286 further comprising;

a first conveyer for moving the first tray having a plurality of devices therein to the first jaw; and

a second conveyer for moving the first tray having a plurality of devices therein from the first jaw.

288. The machine-vision system of claim 286 wherein the first jaw is capable of holding, in any position, a tray devoid of devices.

289. The machine-vision system of claim 286 further comprising;

a slider for transferring the inverted devices from the second jaw into the first tray.